Formal Analysis of Security Protocols
(Group: Crypto)

Presented by : Shruti Biswal

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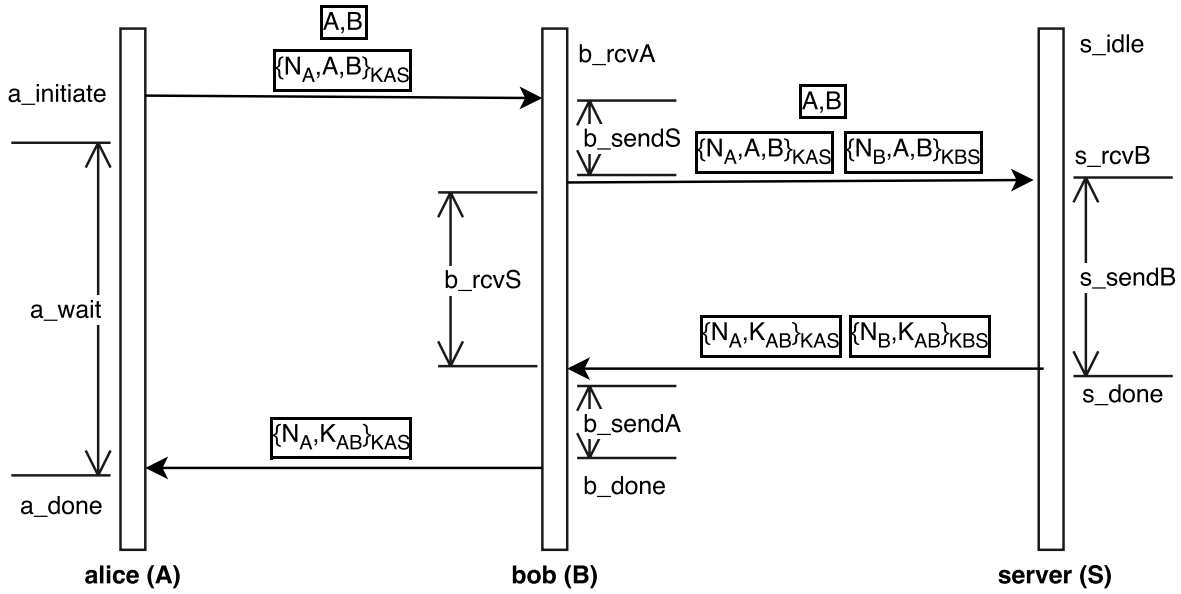
Motivation

- Security Protocols provide the basis for determining authenticated and authorized entities for safe transmission of information
- Need for Formal Analysis : To detect presence of any weakness in the protocol can lead to intrusion and thus, renders the protocol unsafe
- Where is the loophole ? : Most protocols establish the authentication and assume the communication channel to be secure.

Protocols Modelled For Attack Detection...

- Otway-Rees Protocol
- Needham - Schroeder Public Key Protocol
- Kerberos Protocol

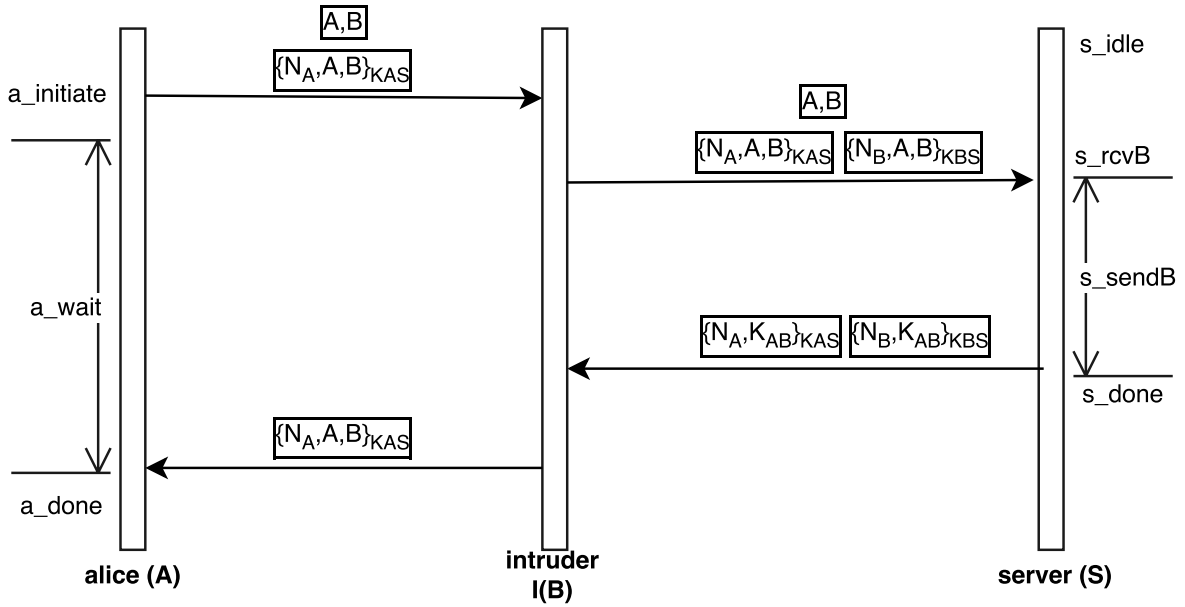
Otway-Rees Protocol



- It is always the case that if Agent A initiates a session then both Agent A and B should reach a state where session is successfully established.

Otway-Rees Model

Attack on Otway - Rees Protocol



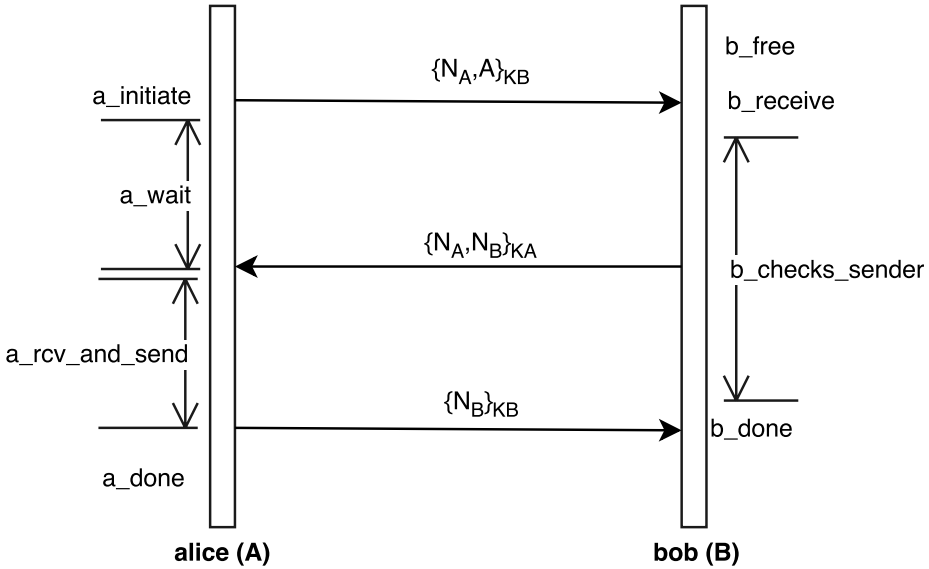
- Violates : If Agent A initiates a session then both Agent A and I(B) reach a state where session is successfully established and the intruder I(B) does NOT share a common key with A

Otway-Rees Model With Attack

Resolution for the Attack

- Can be resolved if the agent A in the last run expects to receive two packets where the first packet contains the encryption key for the second packet. In such scenario, the intruder I(B) cannot attack by re-sending an older message.

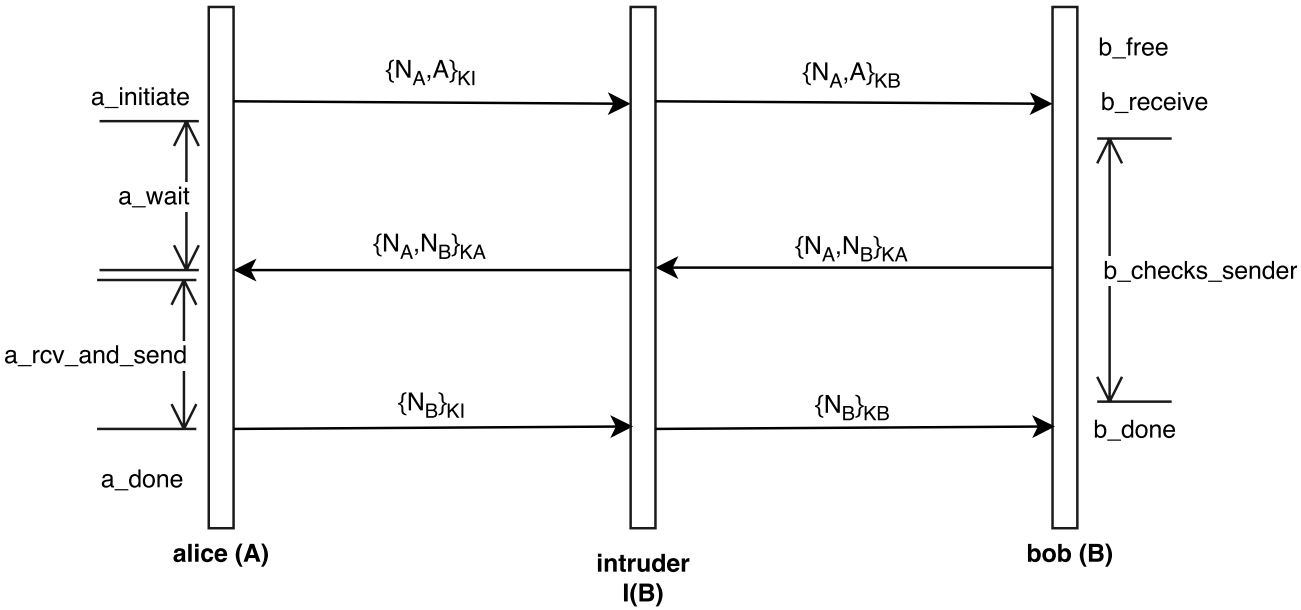
Needham Schroeder



- It is always the case that if Agent A initiates a session then both Agent A and B should reach a state where session is successfully established.

Needham Shcroeder Model

Attack on Needham Schroeder Protocol



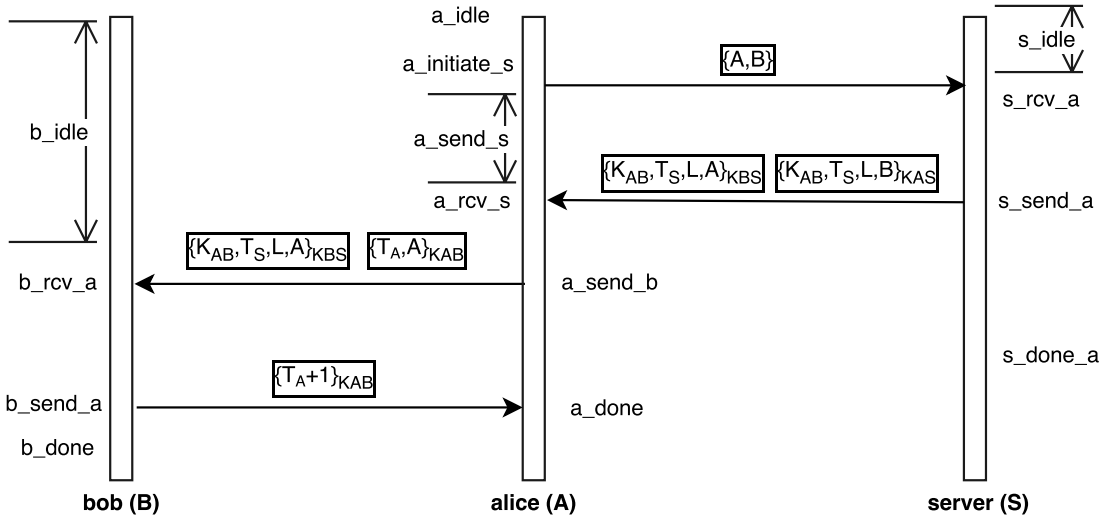
- Violates : If Agent A initiates a session then both Agent A and B reach a state where session is successfully established and the intruder I does NOT have the secret information from A and B

Needham Schroeder Model With Attack

Resolution for the Attack

- The attack was of type impersonation where the intruder pretended to be agent A with agent B.
- Can be resolved if agent B sends its identifier to I, which would further require A to receive an identifier for I (which he cannot generate due to the encryption key).

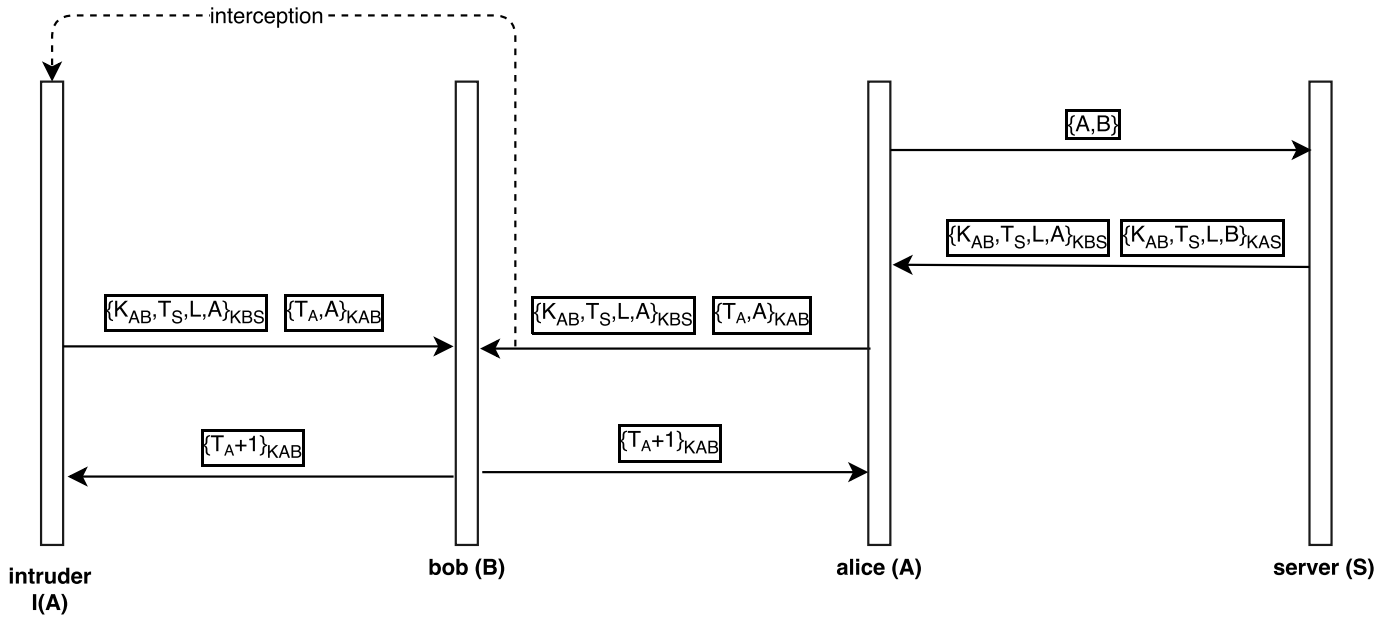
Kerberos Protocol



- **Authentication** : It is always the case that the number of sessions started by Agent A with B >= Number of sessions Agent B accepts with A.
- **Secrecy and Integrity**: Number of session keys shared by Agent A with B is >= Number of session keys Agent B accepts from A.

Kerberos Model

Attack on Kerberos Protocol



- **Authentication**: It is always the case that the number of sessions started by Agent I with B >= Number of sessions Agent B accepts with I.
- **Secrecy and Integrity**: Number of session keys shared by Agent I with B >= Number of session keys Agent I accepts from A.

Kerberos Model With Attack

Resolution for the Attack

- The attack was of type replay where the imposter set up a duplicate session with agent B and contacted B earlier than the honest agent A
- Can be resolved if agent B stores all the incoming authenticators from all the live sessions to detect replay.

Conclusion

- Formal analysis of security protocols to detect attack done via introduction of an all-powerful intruder who can eavesdrop, relay or imposter into the protocol model.
- Violation of security property like authentication or secrecy signify the presence of attack.
- Improvements or changes to the protocol help resolve the attack but may also be still vulnerable to a different kind of attack.

References

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